International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Measurement of Granule Density in UASB Reactor

Vidya Singh

Research Scholar, Department of Chemistry, Motilal Nehru National Institute of Technology, Allahabad 211004, U.P India

Abstract: ***To monitor the granularity of anaerobic sludge, the determination of granule density is vital importance. Granular sludge is the key factor for the efficient operation of upflow anaerobic sludge blanket (UASB) reactor. For this reason several techniques have been proposed. In the proposed algorithm, the granular density was calculated. The granular density was strongly correlated with the VSS/TSS ratio.***

Keywords: COD, granular sludge, Hydraulic retention time, UASB reactor, VSS/TSS ratio.

1. Introduction

The last 20 years, many full-scale upflow anaerobic sludge blanket (UASB) reactors have been constructed to treat industrial wastewater. More than 900 UASB units are currently operating all over the world [1, 2]. The limitations of UASB reactors are related to the wash out of biomass. So, the granulation process is a pre-requisite of a UASB system start-up and operation. The treatment capacity of a UASB system depends on whether granulation is accomplished with particular operating conditions, e.g. wastewater composition, organic loading rate, temperature, etc.[3, 4]. The quality and stability of sludge directly dictates the behaviour of the entire treatment system. One of the most important characteristics is their size distribution. This size with their density defines the settling properties of the sludge, an attribute that is fundamental from the operational point of view [3].

The UASB reactor is considered desirable in high-strength organic wastewater treatment because of its high biomass concentration and rich microbial diversity [5-9]. The high biomass concentration implies that contaminant transformation is rapid, and highly concentrated or large volumes of organic waste can be treated in compact reactors. As compared to other anaerobic technologies, such as anaerobic filter, anaerobic sequencing batch reactor, anaerobic expanded bed and fluidized bed reactors, the UASB system is highly dependent on its granulation process with a particular organic wastewater. Anaerobic granular sludge is the core component of a UASB reactor [10]. Many factors contribute, in one form or another, to the granulation process [11, 12]. Granulation may be initiated by bacterial adsorption and adhesion to inert matters, to inorganic precipitates and/or to each other through physicochemical interactions and syntrophic associations. These substances serve as initial precursors (carriers or nuclei) for further bacterial growth. These initial granules will grow continuously into compact mature granules, if favourable conditions pertaining to bacteria are maintained [13]. The inorganic precipitates contribute not only to the settling characteristics but also to granule stability. The aim of this work was to investigate the formula for measuring granule density in UASB reactor.

2. Data Collection and Methodology

For the measurement of granule density in UASB reactor using the formula observed in [14]. Experimental data of granule density in [14] lies between 1000-1390 kg/m3. For validation of observed formula of granule density using the experimental data of [15] was used. For validation of formula two aspects of experimental data used. First aspects are influent conditions of UASB reactor, other is effluent data of UASB reactors. Using above two aspects of data points validate the formula of granule density in UASB reactor.

3. Results and Discussion

3.1 Granule Density

In [14] a large number of samples from four UASB reactors operating under different conditions like loading rates, metal addition and temperature were collected for period of two months. For these samples, the total and volatile suspended solids concentrations as well as their density were determined. A significant correlation between the granule density and the ratio VSS/TSS of the sludge given below in equation 1 .

$$\rho_g = 1387 - 3.77\frac{VSS}{TSS} \qquad (1)$$

In which VSS/TSS is the % of volatile suspended solids and ρ_g is density of granules.

3.2 Validation of Approach of Granule Density

In [14] experimental granule density lies between 1000 to 1390 kg/m3. In figure 1 variation of observed granule density obtained from equation 1 with VSS/TSS was given. Observed granule density from equation 1 was lies between 1382-1386 kg/m3, these values of granule density lies between the experimental values of [14]. In Figure 1 influent values of volatile suspended solids, total suspended solids and granule density are observed.

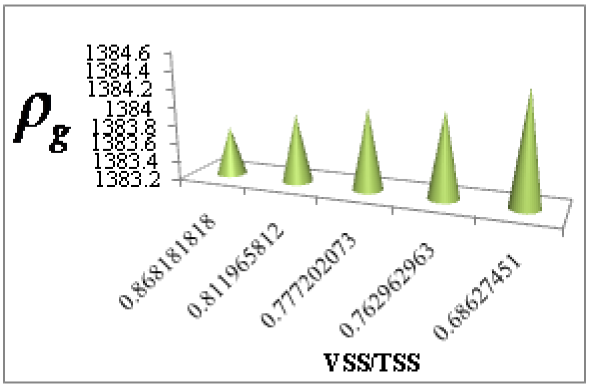

Figure 1: Variation of influent VSS/TSS with granule density

In Figure 2 effluent values of volatile suspended solids, total suspended solids and granule density are observed. Ratio of effluent volatile suspended solids and total suspended solids lies up to 0.86 to 0.999.

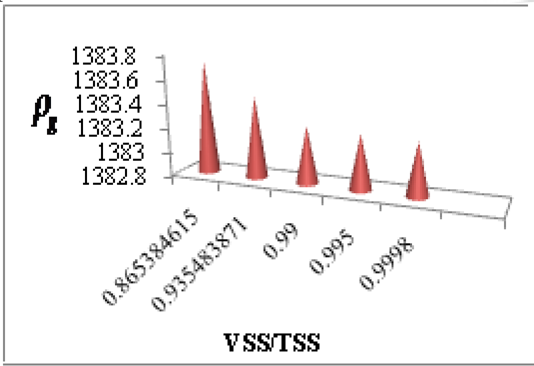

Figure 2: Variation of effluent VSS/TSS with granule density

3.3 Performance of Reactor

The term "performance of reactor" is defined as, which are given below-

$$\text{COD digestion rate} = \frac{COD_{in} - COD_{out}}{COD_{in}} * 100 \quad (2)$$

For low loading rate, the COD digestion rate in each reactor was excellent (higher than 80%) However, when the COD loading rate was increased, COD digestion rate was decreased. The digestion rate shown in figure 3, in all operation COD digestion rate is more than 54% means performance of the reactor was better.

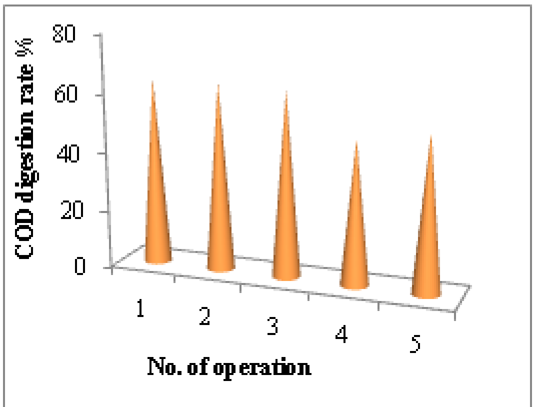

Figure 3: Performance of reactor during different operations

4. Conclusions

UASB reactor shows best commercial acceptance among all different types of anaerobic digesters. The success of these reactors is related to their capacity for biomass accumulation by settling without need of a carrier. Good settling properties are obtained through the flocculation of the biomass of in the form of dense granules with diameters up to several millimetres. Density of granules was highly dependent on VSS/TSS ratio of influent and effluent conditions of reactor.

5. Acknowledgments

Authors are grateful to MHRD, New Delhi MNNIT, Allahabad for their help in compiling and preparing this manuscript.

References

[1] M. Alves, A.J. Cavaleiro, E.C. Ferreira, A.L. Amaral, M. Mota, M. da Motta, H. Vivier, M.N. Pons, Characterization by image analysis of anaerobic sludge under shock conditions, Water Sci. Technol. 41, 2000, 207–214.
[2] Y. Liu, H.L. Xu, K.Y. Show, J.H. Tay, Anaerobic granulation technology for wastew- ater treatment, World J. Microb. Biotechnol. 18, 2002, 99–113.
[3] Jeison, D., Chamy, R. Novel technique for measuring the size distribution of granules from anaerobic reactors for wastewater treatment. Biotechnol. Technol. 12(9), 1998, 659-662.
[4] Xu, H, L., Tay, J. H., Preserved granular sludge for inoculation of new UASB reactors, J. Env. Sci. Health A 36(9), 2001, 1747-1756.
[5] J.E. Schmidt, B.K. Ahring, Granular sludge formation in upflow anaerobic sludge blanket (UASB) reactors, Biotechnol. Bioeng. 49, 1996, 229–246.
[6] L.W. Hulshoff Pol, The Phenomenon of Granulation of Anaerobic Sludge. PhD Thesis, Wageningen Agricultural University, The Netherlands, 1989.
[7] G. Lettinga, A.D. Man, A.R.M. ver der Last, W. Wiegant, K. van Knippenberg, J. Fri-jns, J.C.L. van Buuren, Anaerobic treatment of domestic sewage and wastewater, Water Sci. Technol. 27, 1993, 67–73.
[8] M.M. Ghangrekar, S.R. Asolekar, S.G. Joshi, Characteristics of sludge developed under different loading conditions during UASB reactor start-up and granula-tion, Water Res. 39 (6) ,2005, 1123–1133.
[9] H.H.P. Fang, H.K. Chui, Y.Y. Li, T. Chen, Performance and granule characteristics of UASB process treating wastewater with hydrolyzed proteins, Water Sci. Technol 30,1994, 55–63.
[10] Y. Liu, H.L. Xu, S.F. Yang, J.H. Tay, Mechanisms and models for anaerobic gran-ulation in upflow anaerobic sludge blanket reactor, Water Res. 37 (3), 2003, 61–73.
[11] W.J. De Zeeuw, Acclimatization of anaerobic sludge for UASB reactor start-up. PhD Thesis, Wageningen Agricultural University, The Netherlands, 1984.
[12] H.H.P. Fang, H.K. Chui, Y.Y. Li, Effect of degradation kinetics on the microstructure of anaerobic biogranules, Water Sci. Technol. 32 ,1995, 165–172.
[13] Y. Liu, H.L. Xu, S.F. Yang, J.H. Tay, Mechanisms and

models for anaerobic gran-ulation in upflow anaerobic sludge blanket reactor, Water Res. 37 (3), 2003, 61–73.
[14] Vlyssides , A., Barampouti. E. L., Mai,S. Determination of granule size distribution in a UASB reactor. Journal of environmental management 86, 2008, 660-664.
[15] Alvarez, J.A., Armstrong, E., Gomez, M., Soto, M. Anaerobic treatment of low strength municipal wastewater by a two stage pilot plant under psychrophilic conditions. 99, 2008, 7051-7062.